Center Innovation Fund: AFRC CIF

Electro-Magnetic Flow Control to Enable Natural Laminar Flow Wings

Completed Technology Project (2011 - 2012)

Project Introduction

This research team has developed a solid-state electromagnetic device that, when embedded along the leading edge of an aircraft wing, can disrupt laminar air flow on command. The methodology employs a combination of high-voltage AC and DC electric fields and high-strength magnets to generate cross flow. This cross flow either forms vortices or trips the flow to turbulent (depending on conditions), energizing the boundary layer to keep the flow attached and prevent stall. Presumed usage would be for an aircraft to activate the device at take off, turn the device off after gear-up and initial climb-out, then turn back on for descent and landing. Using natural laminar flow principles in aircraft design can reduce fuel burn by 6 to 12 percent. Work to date: The device has been tested on a flat plate in a wind tunnel. Looking ahead: In 2014, the group plans to test the device on a Dryden Remotely Operated Integrated Drone (DROID) aircraft and is targeting 2015 for tests on a Prototype Technology Evaluation Research Aircraft (PTERA). Partner: Brigham Young University provides a wind tunnel and machining facilities to build test articles. Benefits Efficient: Enables fuel reduction Simple: Works with no moving parts, simplifying fabrication and maintenance Improves safety: Facilitates safer takeoffs and landings Applications Aircraft wings Industrial fluid processing Heat transfer processes

This research aims to enable the use of high speed natural laminar flow airfoils by the addition of an electromagnetic flow control device. The device consists of an emitter wire and collection plate mounted flush on a wing surface, with magnets mounted between them, just below the surface. A high voltage signal is applied to the emitter wire while the collection plate is grounded, which sets up an electric field and ionizes the air. As the ions pass through the magnetic field, the Lorentz force directs flow along the wing span, creating vortices that prevent separation. The primary result of this project is an analytical model of the electromagnetic flow control device.

Anticipated Benefits

The technology has the potential to promote green aviation.

- **Efficient:** Enables fuel reduction
- **Simple:** Works with no moving parts, simplifying fabrication and maintenance
- **Improves safety:** Facilitates safer takeoffs and landings

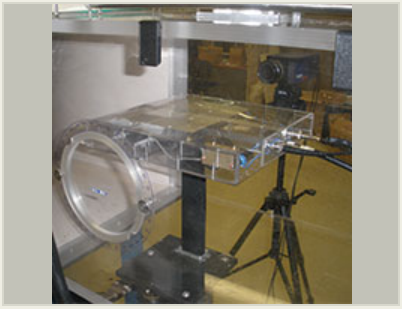

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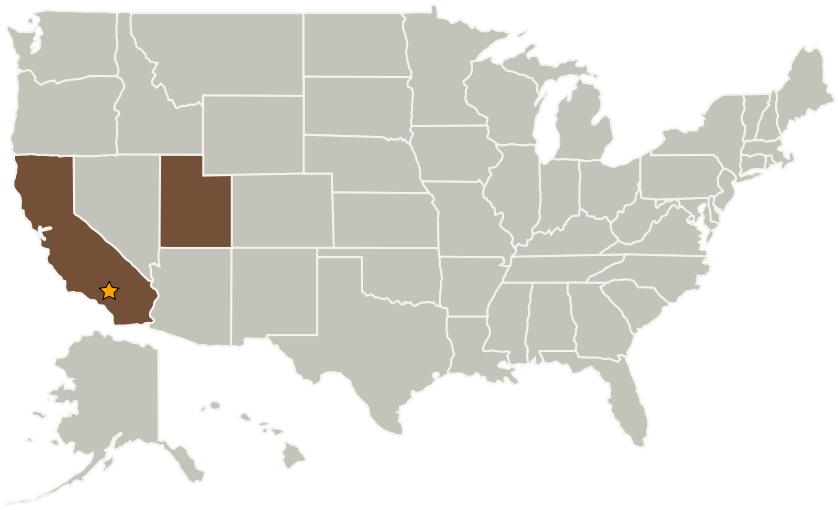
Table of Contents

Electro-Magnetic Flow Control to Enable Natural Laminar Flow Wings

Completed Technology Project (2011 - 2012)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Armstrong Flight Research Center(AFRC)	Lead Organization	NASA Center	Edwards, California
Brigham Young University-Provo	Supporting Organization	Academia	Provo, Utah

Primary U.S. Work Locations	
California	Utah

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Center / Facility:

Armstrong Flight Research Center (AFRC)

Responsible Program:

Center Innovation Fund: AFRC CIF

Project Management

Program Director:

Michael R Lapointe

Program Manager:

David F Voracek

Project Manager:

Minoo N Dastoor

Principal Investigator:

Joel C Ellsworth

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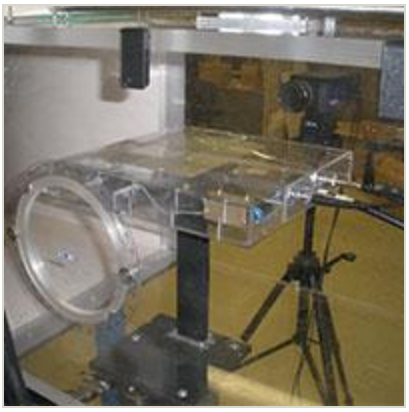
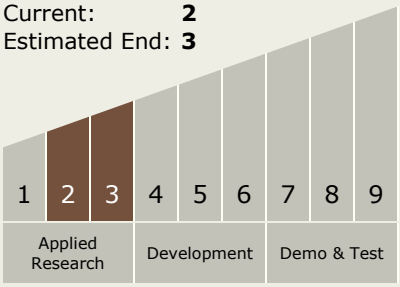
Images



Electro-Magnetic Flow Control to Enable Natural Laminar Flow Wings
Electro-Magnetic Flow Control to Enable Natural Laminar Flow Wings *(https://techport.nasa.gov/image/6601)*

Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX15 Flight Vehicle Systems
  - TX15.1 Aerosciences
    - TX15.1.1 Aerodynamics